like a gnu or horse, and not one with a terminally tufted tail of the ox type. Again, the general form of the animal is much more like that of a gnu than of a bull.

Accordingly, there appears a very strong presumption that this sculpture represents the hunting of a species of gnu, and if this be really the case, it would be a fact of very considerable interest in connection with animal distribution. The two living species of gnu are now confined to Africa, but their near relatives, the hartebeests, range into Syria, while fossil species of that group, as well as of other antelopes of an African type, occur in the Upper Tertiary strata of northern India and China. Nothing is therefore more likely than that gnus should have formerly

Bull Hunt.

FIG. 8.—A gnu (?) hunt, from Nimroud.

had a more extensive range. If this be so, it would be one more argument in favour of the old view that the present antelope fauna of Ethiopian Africa immigrated into the country from the north, and against the modern theory of its autochthonous origin in Africa itself. For it is surely much more probable that animals should have died out in their ancient habitat and flourished in the country in which there are comparatively new arrivals rather than the converse.

A more extensive and detailed study of the old Assyrian and Babylonian sculptures and of the Egyptian frescoes would doubtless lead to the identification of species of animals other than those mentioned above; but such identifications as I have been able to make are sufficient to demonstrate that the subject has a definite bearing on the past distributional history of mammals, and that it ought not to be neglected by students of that branch of zoology.

R. LYDEKKER.

THE ACTION OF RADIUM EMANATIONS ON DIAMOND.[1]

WHEN diamonds are exposed to the impact of radiant matter in a high vacuum they phosphoresce of different hues, and assume a dark colour, becoming almost black when the bombardment is long continued (*Phil. Trans.*, 1879, part ii., p. 658, par. 625).

Some diamonds blacken in the course of a few minutes, while others require an hour or more to discolour.[2] This blackening is only superficial, and although no ordinary means of cleaning will remove the discoloration, it goes at once when the stone is polished with diamond powder. The fact that the black stain is not affected by ordinary oxidising reagents would seem to show that it is not due to a layer of amorphous carbon; but it might be graphite, which is much more resistant to oxidation. Becquerel has shown that graphite is converted into graphitic oxide by long digestion in a warm mixture of potassium chlorate and strong nitric acid, while diamond—even in a very finely powdered state—is absolutely unaffected by the mixture (*Ann. de Chim. et de Phys.*, [4], vol. xix. p. 392).

Some forms of graphite dissolve in strong nitric acid; others require a mixture of highly concentrated nitric and potassium chlorate to dissolve them, and even with this intense oxidising agent some graphites resist longer than others. M. Moissan has shown that the power of resistance to nitric acid and potassium chlorate is in proportion to the temperature at which the graphite has been formed, and with reasonable certainty we can estimate this temperature by the resistance of the graphite to this reagent.

Judging from the long time required to remove the superficial darkening from diamond, the graphite is as resistant as that formed at the temperature of the electric arc.

On one occasion when I had blackened the surfaces of diamonds by molecular bombardment *in vacuo* M. Moissan was present, and took some away with him for further examination. He subsequently reported the results in the *Comptes rendus*, vol. cxxiv., No. 13. He heated the diamond to 60° in an oxidising mixture of potassium chlorate and fuming nitric acid prepared from monohydrated sulphuric acid and potassium nitrate fused and quite free from moisture. The action on the black layer is very slow. There is produced graphitic oxide, which at an increased temperature yields pyrographitic acid, which is easily destroyed by nitric acid. Hence the variety of carbon which coated the diamond was graphite. The transformation of diamond into graphite requires the high temperature of the electric arc. The higher the temperature to which graphite is raised the greater is its resistance to oxidation. M. Moissan concludes that the temperature reached by the surface of the diamond in my radiant matter tubes is probably about 3600°.

The β-rays from radium having like properties to the kathode stream in a radiant matter tube, it was of interest to ascertain if they would exert a like difference on diamond. Two Bingara diamonds, A and B, weighing respectively 0·960 and 1·020 grains, were selected as near as the eye could judge of the same size and colour—very pale yellow, technically known as "off colour." Diamond A was put in a drawer far removed from radium or any radio-active body. Diamond B was kept close to a quartz tube containing about 15 milligrams of pure radium bromide sealed *in vacuo*. It phosphoresced brightly and continued to glow the whole time of the experiment.

After a fortnight the two diamonds were put side by side and compared. I could see no appreciable difference in colour between them. Diamond B was now replaced close to the quartz tube of radium, and they were kept in contact for six weeks. At the end of that time examination again showed scarcely any difference between the two. The one which had been near the radium might be a little the darker of the two, but the difference was too slight to enable me to speak positively.

Diamond B was now put inside a tube with radium bromide, the salt touching it on all sides, as it was thought possible that a screen of quartz might interfere with the passage of emanations which would act on the diamond. The comparison diamond was kept removed from the emanations as before. The experiment was continued for seventy-eight days, when the two diamonds were again examined. There was now a decided difference in colour between them; diamond A was of its original pale yellow "off colour," and diamond B was of a darker appearance and of a bluish tint, with no yellow colour apparent.

It thus appears that the property which radium emanations possess of darkening transparent bodies which they impinge upon—a property very marked in the case of glass, and less with quartz—also holds good in the case of diamond.

Diamond B was now heated to 50° C. in a mixture of strongest nitric acid and potassium chlorate for ten days, the mixture being renewed each day. At the end of this time the diamond had lost its dull surface colour, and was as bright and transparent as the other stone, but its tint had changed from yellow to a pale blue-green.

The radium emanations have therefore a double action on the diamond. The β-rays (electrons) effect a superficial darkening, converting the surface into graphite in a manner similar to, but less strongly than, the more intense electrons in the kathode stream. But the alteration of the body colour of the stone by emanations which are obstructed by the thinnest film of solid matter, even by a piece of thin paper, is not so easy to understand. A superficial action might be expected, but not one penetrating through the whole thickness of the diamond. I believe the alteration

[1] Read before the Royal Society on June 16 by Sir William Crookes, F.R.S.

[2] At a lecture before the Royal Institution on June 11, 1897, I exposed a flat macle crystal of diamond to radiant matter bombardment before the audience for about five minutes, a strip of metal covering part of the stone. On removing the diamond from the vacuum tube and projecting its image on the screen with the electric lantern, the image of the darkening was very apparent.

of colour is a secondary effect; in presence of radium the diamond is extremely phosphorescent, and it continues to shine during the whole time of the experiment. This constant state of vibration in which the diamond was kept for many weeks may have caused an internal change revealing itself in a change of colour. Indeed, it is not difficult to suppose that a chemical as well as a physical action may result. If the yellow colour is due to iron in the ferric state a reduction to the ferrous state would quite account for the change of colour to a pale blue-green.

This alteration of colour may be of commercial importance. If "off colour" stones can be lightened their value will increase, while if the prolonged action of radium is to communicate to them a decided colour they would be worth much more as "fancy" stones.

[*Added June* 16.—After the ten days' heating in the above acid mixture the two diamonds were put together in a glass tube and carried about for twenty-five days, sometimes loose and sometimes in the tube. They then were laid near together on a sensitive film in total darkness for twenty-four hours. On developing, diamond B had impressed a strong image on the film, but only a very faint mark could be seen where the other diamond had been. Probably this slight action was due to a little radio-activity induced in A during its twenty-five days' proximity to B.

The experiment was then repeated for confirmation, allowing the diamonds to remain on the sensitive surface for only five hours. On development, a good image of diamond B was seen, but not so black as in the former case.

The fact that diamond B was strongly radio-active after it had been away from radium for thirty-five days, for ten of which it was being heated in a mixture powerful enough to dissolve off its outer skin of graphite, seems to me proof that radio-activity is by no means a simple phenomenon. It not merely consists in the adhesion of electrons or emanations, given off by radium, to the surface of an adjacent body, but the property is one involving deep-seated layers below the surface, and like the alteration of tint is probably closely connected with the intense phosphorescence the stone had been experiencing during its seventy-eight days' burial in radium bromide.]

THE MARKINGS AND ROTATION PERIOD OF MERCURY.

MUCH new light was thrown upon the rotation period of Saturn during the year 1903, and it seems highly probable that the next planet to afford us information as to the same feature will be the planet Mercury. Spots of very definite and distinct character are certainly visible on the surface of this fugitive little orb, which offers a more promising field for new discoveries than Venus, though it is considerably smaller, at a much greater distance from us, and more unfavourably placed for observation. The markings sometimes perceptible on Mercury appear to be of sufficient prominence to be followed, and if really capable observers are forthcoming, at the opportune period, to study them, it will be possible to ascertain once and for all whether this circumsolar planet turns on its axis once in about 24 hours or 88 days, and an important advance in our knowledge will have been made.

Spots have been discerned on Mercury since the time of Schroeter about a century ago. Among those who have obtained observations of them are the following:—

Schroeter	1800	Denning	1882
Harding	1801	Schiaparelli ...	1882-3
Bessel	1801	Brenner	1896
Prince	1867	Lowell	1896
Birmingham ...	1870	Barnard . . .	1900
Vogel	1871	McHarg	1904

In 1800 Schroeter announced that the rotation period was about 24h. 4m. from blunted appearances of the southern horn, but doubted if the value could be determined to within a few minutes. In 1801 Harding perceived a dusky spot in the southern hemisphere, and derived the period as 24h. 5m. 30s. Further observations, however, obtained by himself and Bessel caused him to reduce this period to 24h. 0m. 50s. Bessel found 24h. 0m. 53s. from several of Schroeter's observations extending over fourteen months. In 1882 Denning, at Bristol, thought a period of about 25 hours would satisfy the observations, but Schiaparelli, in the pure Italian sky, arrived at very different results, and concluded that the planet rotated in 88 days, or in the same period as he revolved round the sun. Quite recently McHarg found the time 24h. 8m. from his own observations of a dark spot in April, 1904. He also deduced a period of 24h. 5m. 48s. from a blunting of the southern horn seen by Schroeter in 1800 March, and by Denning in 1882 November.

ON THE DIMENSIONS OF DEEP-SEA WAVES, AND THEIR RELATION TO METEOROLOGICAL AND GEOGRAPHICAL CONDITIONS.[1]

THE following table has been compiled from the original sources after re-calculating the true velocities corresponding to the "Beaufort numbers" in accordance with the alteration of reduction factor adopted by meteorologists since the date of the observations:—

Table showing the Relation between the True Velocity of the Wind in Statute and in Geographical Miles per Hour and the Height of the Wave in Feet, as deduced from Observations by numerous French Observers extending over many years and taking in all the Oceans.

No. of wind on Beaufort's scale of 0–12	Velocity of wind, stat. miles per hour	Velocity of wind, geographical miles per hour	Height of wave in feet	Authority	Velocity of wind in stat. miles per hour divided by height of wave in feet	Velocity of wind in geographical miles per hour, divided by height of wave in feet
						Feet
0·00	2·0	1·7	1·97	Desbois	1·01	0·86
1·50	5·5	4·8	3·28	,,	1·68	1·46
3·00	10·0	8·7	4·92	,,	2·03	1·77
3·60	12·4	10·8	6·17	Antoine	2·01	1·75
4·36	15·8	13·7	6·56	Paris	2·41	2·09
4·50	16·5	14·3	7·55	Desbois	2·19	1·89
4·80	18·0	15·6	9·12	Antoine	1·97	1·71
5·45	21·7	18·9	13·45	Paris ("Grosse Houle")	1·61	1·41
6·00	25·0	21·7	10·83	Desbois	2·31	2·01
6·00	25·0	21·7	13·12	Antoine	1·91	1·65
6·55	28·3	24·6	11·65	Paris	2·43	2·11
7·20	32·2	28·0	17·0	Antoine	1·89	1·65
7·50	34·0	29·5	15·42	Desbois	2·20	1·91
8·18	38·3	33·3	16·57	Paris	2·31	2·01
8·40	39·8	34·6	16·73	Antoine	2·38	2·07
9·00	44·0	38·2	20·67	Desbois	2·13	1·85
9·60	49·2	42·7	21·98	Antoine	2·24	1·94
9·82	52·2	45·3	25·43	Paris	2·05	1·78
10·50	58·2	50·5	28·54	Desbois	2·04	1·77
10·8	61·8	53·7	27·89	Antoine	2·22	1·93
				Average	2·03	1·78

This table gives the average of many hundreds of days' observations conducted at various times during a period of about forty years by independent observers, all French seamen of the navy or merchant service, carried out in almost all parts of the oceans ordinarily visited by ships, and from many different vessels (none, however, of the great size of our modern liners, and therefore better for such observations), and shows the average height of the wave, in open sea with sufficient depth of water, to be in simple arithmetical proportion to the velocity of the wind, *the height of the wave in feet being in round numbers one-half of the velocity of the wind in statute miles per hour.*

This result does not express a dynamical law; it is simply

[1] Extracted from a paper by Dr. Vaughan Cornish in the *Geographical Journal* for May, 1904.